MATHS

BOOKS - NAGEEN PRAKASHAN ENGLISH

COMPLEX NUMBERS AND QUADRATIC EQUATION

Solved Examples

1. Find the values of the following :

(i) i^{73}

(ii) i^{-6}

(iii) $\frac{1}{i}$

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2. Simplify the following :

(i) $1 + i^5 + i^{10} + i^{15}$

(ii) $(1+i)^4 + \left(1 + \frac{1}{i}\right)^4$

(iii) $i^n + i^{n+1} + i^{n+2} + i^{n+3}$

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3. Simplify $\sqrt{-16} \times \sqrt{-25}$.

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4. $(-i)^{4n+3}$, where n Is a positive integer. Then prove that it is equals to i

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5. Convert in the form of (a + ib) :

3(1+i)-2(2+3i)

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6. Convert $\frac{4-i\sqrt{3}}{4+i\sqrt{3}}$ in the form of $a+ib$.

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7. Convert $\left(\frac{1}{2}+2i\right)^3$ in the form of $a+ib$.

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8. Convert $\frac{(2+3i)^2}{2-i}$ in the form of $a+ib$ and find its conjugate.

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9. Find the conjugate of $\frac{(3-2i)(2+3i)}{(1+2i)(2-i)}$.

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10. Simplify : $\frac{1+2i}{1-2i} - \frac{1-2i}{1+2i}$

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11. Find the values of x and y: (i) $x+3i = 6-9iy$ (ii) $(x+iy)-(3-2i) = 5+i$ (iii) $i = x+2yi$ (iv) $4x+i(x-y) = 2-5i$ (v) $(x+2iy)(2-i)^2 = 10(1-i)$

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12. If $z = 2-3i$ show that $z^2 = 4z+13 = 0$ and hence find the value of $4z^3 - 3z^2 + 169$.

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13. Write the order pair $(2, -3)$ in the form of $(a + ib)$.

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14. Prove that $\frac{3+i}{1+2i} + \frac{3-i}{1-2i}$ is a real number.

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15. Find the multiplicative inverse of $(4 + 3i)$.

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16. If z is a complex number and $z = \bar{z}$, then prove that z is a purely real number.

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17. Find the square roots of the following: $7 - 24i$ (ii) $5 + 12i$

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18. Find the square root of $(- 8 - 6i)$.

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19. Find real q such that $\frac{3 + 2i \sin \theta}{1 - 2i \sin \theta}$ is purely real.

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20. Convert the complex number $\left(1 + i\sqrt{3}\right)$ into polar form.

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21. Convert the complex number $z = \frac{i - 1}{\frac{\cos \pi}{3} + i\frac{\sin \pi}{3}}$ in the polar form.

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22. If $z_1 = 2 - i, z_2 = 1 + i$, find $\left| \frac{z_1 + z_2 + 1}{z_1 - z_2 + i} \right|$

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23. If z is a complex number such that $|z| = 1$, prove that $\frac{z-1}{z+1}$ is purely imaginary, what will by your conclusion if $z = 1$?

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24. Solve the equation $x^2 + 2 = 0$.

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25. Solve the equation $x^2 + 9 = 0$ by factorization method.

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26. Solve the equation $x^2 - 6x + 25 = 0$ by factorization method.

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27. Solve the equation $x^2 + x + \frac{1}{\sqrt{3}} = 0$

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28. Solve the equation $x^2 + 2ix + 15 = 0$.

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29. Solve the equation $x^2 - \left(2\sqrt{2} + 3i\right)x + 6i\sqrt{2} = 0$ by factorization method.

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30. Solve the eqution

$x^2 + ix\sqrt{3} + 18 = 0.$

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31. Solve the following quadratic equation:

$x^2 - (2 + i)x - (1 - 7i) = 0$

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Exercise 5 A

1. Simplify the following :

(i) i^{97}

(ii) i^8

(iii) $\frac{1}{i^3}$

(iv) $(-i)^{14}$

(v) i^{-22}

(vi) i^{-63}

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2. Find the values of the following : (i) $i^7 + i^{17} + i^{12}$ (ii) $i^{11} + i^{-11}$ (iii) $i^3 + \frac{1}{i^3}$ (iv) $1 + i^2 + i^6 + i^8$

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3. Show that : $i^{101} + i^{102} + i^{103} + i^{104} = 0$

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4. Show that : $\frac{1}{i} + \frac{1}{i^2} + \frac{1}{i^3} + \frac{1}{i^4} = 0$

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5. Show that $6i^{50} + 5i^{17} - i^{11} + 6i^{28}$ is an imaginary number.

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6. Show that $i^{15} + i^{17} + i^{19} + i^{21} + i^{24}$ is a real number.

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7. Simplify the following :

(i) $\sqrt{-25} \times \sqrt{-36}$

(ii) $\sqrt{-25} \times \sqrt{49}$

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8. Simplify : $3\sqrt{-16} - 2\sqrt{-9} + 4\sqrt{-36}$

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9. Simplify the following :

(i) $\left[i^{19}+\frac{1}{i^{25}}\right]^2$

(ii) $\left[i^5-\frac{1}{i^3}\right]^4$

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Exercise 5 B

1. Convert the following in the form of $(a+ib)$:

(i) $(1+i)^4$

(ii) $\left(-3+\frac{1}{2}i\right)^3$

(iii) $(1-i)(3+4i)$

(iv) $(1+i)(1+2i)(1+3i)$

(v) $\frac{3+5i}{6-i}$

(vi) $\frac{(2+3i)^2}{2+i}$

(vii) $\frac{(1+i)(2+i)}{(3+i)}$

(viii) $(2-i)^{-3}$

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2. Convert the following in the polar form : (i) $\frac{1+7i}{(2-i)^2}$ (ii) $\frac{1+3i}{1-2i}$

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3. Perform the indicated operation and find the result in the form $a+ib$: $\frac{3-\sqrt{-16}}{1-\sqrt{-9}}$

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4. Prove that $\left(\frac{-1+i\sqrt{3}}{2}\right)^3$ is a positive integer.

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5. Convert $\left[\frac{3+2i}{3-2i}+\frac{3-2i}{3+2i}\right]$ in the form of $(a+ib)$.

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6. Prove that : (i) $\sqrt{i} = \frac{1+i}{\sqrt{2}}$ (ii) $\sqrt{-i} = \frac{1-i}{\sqrt{2}}$ (iii) $\sqrt{i} + \sqrt{-i} = \sqrt{2}$

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7. Find the sum and product of the complex number $(3-4i)$ with its conjugate.

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8. Find the sum and product of the complex number $(-1+2i)$ with its conjugate.

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9. Find the multiplicative inverse of the following complex number: $\left(2+\sqrt{3}i\right)^2$

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10. Write the following in the form of ordered pair :

(i) $3 - 2i$

(ii) $a + bi$

(iii) $-3 - 2i$

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11. Convert the following in the form of a complex number :

(i) $(2, -5)$

(ii) $(-3, 1)$

(iii) $(0, -2)$

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12. Find the values of x and y from the following : (i) $(3x - 7) + 2iy = -5y + (5 + x)i$ (ii) $2xi + 12 = 3y - 6i$ (iii)

$z = x + iy$ and $i(z + 2) + 1 = 0$ (iv)

$\frac{(1+i)x - 2i}{3+i} + \frac{(2-3i)y + i}{3-i} = i$ (v) $(3x - 2iy)(2+i)^2 = 10(1+i)$

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13. If $z = 1 + 2i$, show that $z^2 - 2z + 5 = 0$. Hence find the value of $z^3 + 7z^2 - z + 16$.

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14. $Z = -5 + 4i$then $Z^4 + 9Z^3 + 35Z^2 - Z + 4 =$

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15. If $z_1 = 2 - i$, $z_2 = 1 + 2i$, then find the value of the following :

(i) $Re\left(\frac{z_1 \cdot z_2}{\bar{z}_2}\right)$

(ii) $Im(z_1 \cdot \bar{z}_2)$

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16. If $x+iy=\frac{a+ib}{a-ib}$, prove that $x^2+y^2=1$.

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17. $(x+iy)^{\frac{1}{3}}=(a+ib)$ then prove that $\left(\frac{x}{a}+\frac{y}{b}\right)=4\left(a^2-b^2\right)$

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18. If $\frac{\left(a^2+1\right)^2}{2a-i}=a+iy$, then what is the value of $x^2+y^2>$

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19. Write the least positive integral value of n for which $\left(\frac{1+i}{1-i}\right)^n$ is real.

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20. The complex number z is purely imaginary , if

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21. A number of the form a + ib is called a complex number, where $a, b \in R$ and $i = \sqrt{-1}$ Complex number is usually denoted by Z and the set of complex number is represented by C. Thus $C = \{a + ib : a, b \in B \text{ and } \equiv \sqrt{-1}\}. IfZ = a + ib$ is a complex number then $\bar{z}a = -ib$ is called as conjugate. Two complex numbers $z1 = a1 + ib_1 \& z2 = a2 + ib2$ are equal if and only if their real and imaginary parts are equal respectively. i.e., $z_1 = z_2 \Leftrightarrow Re(z_1) = Re(z_2)$ and $Im(z_1) = Im(z_2) \Leftrightarrow a_1 = a_2$ and $b_1 =$

The following algebric operations can be performd on complex numbers.

1. Addition $(a + bi) + (c + bi) = a + bi + c + di = (a + c) + (b$
2. Subtraction $(a + b) - (c + di) = a + bi - c - di = (a - c) + (b$
3. Multipication $(a + b)(c + di) = ac + adl + bci + bdi2 = (ac - bd)$
4. Multiplication $\frac{a+bi}{c+di} = \frac{a+di}{c+di} \cdot \frac{c-di}{c-di} = \frac{ac+bd}{c^2+d^2} + \frac{bc-ad}{c^2+d^2} i$

Using above comprehension answer the followings :

$\left(\frac{4i^3 - i}{2i + 1}\right)^i$ can be expressed in a = ib as

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22. Find the real values of θ for which the complex number $\frac{1+i\cos\theta}{1-2i\cos\theta}$ is purely real.

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23. Find the square root of the following :

(i) $3-4i$

(ii) $4+6i\sqrt{5}$

(iii) $-i$

(iv) $8i$

(v) $-7+24i$

(vi) $-24-10i$

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24. If $x+iy=\frac{3}{2+\cos\theta+i\sin\theta}$, then show that $x^2+y^2=4x-3$

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25. The sum and product of two complex numbers are real if and only if they are conjugate of each other.

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26. If $\frac{1+x}{1-x} = \cos 2\theta + i \sin 2\theta$, prove that that $x = i \tan \theta$.

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27. If $x = \cos \alpha + i \sin \alpha, y = \cos \beta + i \sin \beta,$ then prove that $\frac{x-y}{x+y} = i(\tan)\frac{\alpha - \beta}{2}$

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28. Prove that: $x^4 = 4 = (x+1+i)(x+1-i)(x-1+i(x-1-i).)$

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29. Evaluate : $\left(4+3\sqrt{-20}\right)^{1/2}+\left(4-3\sqrt{-20}\right)^{1/2}$

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Exercise 5 C

1. Convert the following into polar form :

(i) $-1+i\sqrt{3}$

(ii) $1-i$

(iii) $1-\frac{1}{i}$

(iv) $3-4i$

(v) $\sin 120^\circ - i\cos 120^\circ$

(vi) 2

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2. Find the modulus and argument of the following :

(i) $-\sqrt{3}+i$

(ii) $-1-i\sqrt{3}$

(iii) $5+12i$

(iv) $3(\cos 300^\circ - i\sin 30^\circ)$

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3. Find the polar form of conjugate of $(1-i)$.

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4. If $z=x+iy$ is any complex number and $|z-1|=|z+1|$ then show that $|z|=y$.

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5. Prove that $|z_1 + z_2|^2 = |z_1|^2$, if z_1 / z_2 is purely imaginary.

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6. Find the modulus of $\frac{1+i}{1-i} - \frac{1-i}{1+i}$.

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7. Convert the complex number $\frac{-16}{1+i\sqrt{3}}$ into polar form.

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8. If for the complex numbers z_1 and z_2, $|z_1 + z_2| = |z_1 - z_2|$ then $Arg z_1 - Arg z_2$ is equal

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9. Prove that the points, represented by complex numbers $(5+8i), (13+20i), (19+29i)$ are collinear.

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10. Find the area and nature of the triangle formed by the points represented by the complex numbers $(3+3i), (-3-3i)$ and $\left(-3\sqrt{3}+3\sqrt{3}i\right)$.

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11. If $z=x+iy$ such that the argument of $\frac{z-1}{z+1}$ is always $\frac{\pi}{4}$. Prove that $x^2+y^2-2y=1$

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12. Find the number of non-zero integral solutions of the equation $|1-i|^x = 2^x$.

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13. If $|z-2| = 2|z-1|$, then show that $|z|^2 = \frac{4}{3}Re(z)$.

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14. For any two complex number $z_1 and\, z_2$ prove that: $|z_1 - z_2| \leq |z_1| + |z_2|$

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Exercise 5 D

1. Solve the following equations by factorization method : (i) $x^2 + 4 = 0$

(ii) $x^2 + 5 = 0$ (iii) $4x^2 + 9 = 0$ (iv) $x^2 - 4x + 29 = 0$ (v) $4x^2 - 12x + 45 = 0$

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2. Solve the following equations by Sridharacharya's formula :

(i) $x^2 + x + 4 = 0$

(ii) $2x^2 - 2x + 3 = 0$

(iii) $\sqrt{2}x^2 + x + \sqrt{2} = 0$

(iv) $x^2 - x + 2 = 0$

(v) $25x^2 - 30x + 11 = 0$

(vi) $x^2 + 3x + 5 = 0$

(vii) $x^2 - 14x + 58 = 0$

(viii) $x^2 + 13ix - 42 = 0$

(ix) $x^2 - 11ix - 30 = 0$

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3. Solve the following equations by factorization method :

$x^2 + 6ix - 9 = 0$

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4. Solve the following equations :

(i) $2x^2 - (3 + 7i)x - 3 + 9i = 0$

(ii) $(2 + i)x^2 - (5 - i)x + 2(1 - i) = 0$

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5. Find the quadratic equation whose one root is $(1 - i)$.

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6. One root of the equation $ax^2 - 3x + 1 = 0$ is $(2 + i)$. Find the value of $'a'$ when a is not real.

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Exercise 5 E

1. The conjugate of the complex number $(a + ib)$ is :

A. $-a - ib$

B. $-a + ib$

C. $a - ib$

D. None of these

Answer: C

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2. Show that a real value of x will satisfy the equation $(1 - ix)/(1 + ix) = a + ib$ if $a^2 + b^2 = 1, where a, b$ real.

A. 1

B. 0

C. -1

D. None of these

Answer: A

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3. If $\frac{3+2i\sin\theta}{1-2i\sin\theta}$ is real , then general value of θ is :

A. $\frac{n\pi}{2}, n \in 1$

B. $n\pi, n \in 1$

C. $\frac{n\pi}{3}, n \in 1$

D. None of these

Answer: B

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4. Convert of the complex number in the polar form: $\sqrt{} + i$

A. $2\left(\cos\frac{\pi}{6} + i\sin\frac{\pi}{6}\right)$

B. $2\left(\cos\frac{\pi}{6} - i\sin\frac{\pi}{6}\right)$

C. $2\left(\cos\frac{\pi}{6} - i\sin\frac{\pi}{6}\right)$

D. None of the above

Answer: A

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5. If z is a complex number and $z = \bar{z}$, then prove that z is a purely real number.

A. $Re(z) = 0$

B. $Im(z) = 0$

C. $Re(z) = Im(z)$

D. None of these

Answer: B

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6. If $x + iy = (1 + 4i)(1 + 5i)$, then $\left(x^2 + y^2\right)$ is equal to :

A. 17

B. 26

C. 442

D. None of these

Answer: C

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7. If z_1, z_2, z_3, represent vertices of an equilateral triangle such that $|z_1| = |z_2| = |z_3|$ then

A. -1

B. 0

C. 1

D. None of these

Answer: B

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8. Find the multiplicative inverse of $z = 3 - 2i$.

A. $\frac{1+2i}{5}$

B. $\frac{1-2i}{5}$

C. $\frac{1+2i}{\sqrt{5}}$

D. None of these

Answer: A

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9. The roots of the equation $x^2 + 6ix - 9 = 0$ are :

A. $\pm i$

B. $\pm 2i$

C. $\pm 3i$

D. None of these

Answer: C

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10. $(1+i)^4 + (1-i)^4$ is equal to

A. 8

B. -4

C. -8

D. None of these

Answer: C

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Exercise 5 F

1. about to only mathematics

A. 2

B. 1

C. 3

D. None of these

Answer: B

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2. Write the least positive integral value of n for which $\left(\frac{1+i}{1-i}\right)^n$ is real.

A. 0

B. 2

C. 4

D. None of these

Answer: C

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3. Statement-1 : The locus of z , if $arg\left(\frac{z-1}{z+1}\right) = \frac{\pi}{2}$ is a circle.

and

Statement -2 : $\left|\frac{z-2}{z+2}\right| = \frac{\pi}{2}$, then the locus of z is a circle.

A. parabola

B. circle

C. pair of two straight lines

D. None of the above

Answer: B

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4. If $z = x + iy$ and $w = \frac{1 - iz}{z - i}$, show that $|w| = 1z$ is purely real.

A. imaginary axis

B. real axis

C. unit circle

D. None of these

Answer: B

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5. For any two complex numbers z_1 and z_2, we have $|z_1 + z_2|^2 = |z_1|^2 + |z_2|^2$, then

A. $Re\left(\frac{z_1}{z_2}\right) = 0$

B. $Im\left(\frac{z_1}{z_2}\right) = 0$

C. $Re(z_1 z_2) = 0$

D. $Im(z_1 z_2) = 0$

Answer: A

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6. Find the complex number z satisfying the equation $\left|\frac{z-12}{z-8i}\right| = \frac{5}{3}, \left|\frac{z-4}{z-8}\right| = 1$

A. $6 + 3i$

B. $6 + 8i, 6 + 17i$

C. $6 + 8i, 6 + 4i$

D. $6 + 17i$

Answer: B

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7. If $|z_1| = |z_2| = |z_3| = \ldots\ldots = |z_n| = 1,$ then $|z_1 + z_2 + z_3 + \ldots\ldots + z_n| =$

A. n

B. $\left|\frac{1}{z} + \frac{1}{z_2} + \ldots + \frac{1}{z_n}\right|$

C. 0

D. None of these

Answer: B

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8. Both the roots of the equation $(x-b)(x-c)+(x-a)(x-c)+(x-a)(x-b)=0$ are always a. positive b. real c. negative d. none of these

A. positive

B. negative

C. real

D. None of these

Answer: C

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9. If one root is common is equations $x^2-ax+b=0$ and $x^2+bx-a=0$, then :

A. $a=b$

B. $a-b=1$

C. $a + b = 1$

D. None of these

Answer: B

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10. If $\alpha \neq \beta$ but $\alpha^2 = 5\alpha - 3$ and $\beta^2 = 5\beta - 3$ then the equation having α/β and β/α as its roots is :

A. $3x^2 - 19x - 3 = 0$

B. $3x^2 - 19x + 3 = 0$

C. $3x^2 + 19x + 3 = 0$

D. None of these

Answer: B

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Exercise 5 1

1. Express of the complex number in the form $a + ib$. $(5i)\left(-\frac{3}{5}i\right)$

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2. Express in the form of complex number $i^9 + i^{19}$

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3. i^{-39}

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4. Express of the complex number in the form $a + ib$. $3(7 + i7) + i(7 + i7)$

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5. Express of the complex number in the form $a+ib$.

$(1-i)-(-1+i6)$

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6. Express of the complex number in the form $a+ib$.

$\left(\frac{1}{5}+i\frac{2}{5}\right)-\left(4+i\frac{5}{2}\right)$

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7. Express each of the following in the form $a+ib$: $\left\{\left(\frac{1}{3}+\frac{7}{3}i\right)+\left(4+\frac{1}{3}i\right)\right\}-\left(-\frac{4}{3}+i\right)$

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8. Express the following in the form a+bi

$(1-i)^4$

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9. Express each of the following in the form $a+ib$: $\left(\frac{1}{3}+3i\right)^3$

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10. Express the following in the form a+bi

$\left(-2-\frac{1}{3}i\right)^3$

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11. Find the multiplicative of the following complex number: $4-3i$

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12. Find the multiplicative inverse of the complex number $\sqrt{5}+3i$

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13. $f \in d\mu < iplicative \in verseof - i$

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14. Express the following expression in the form of $a+ib$

$$\frac{\left(3+i\sqrt{5}\right)\left(3-i\sqrt{5}\right)}{\left(\sqrt{3}+\sqrt{2}i\right)-\left(\sqrt{3}-i\sqrt{2}\right)}$$

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Exercise 5 2

1. $z=-1-i\sqrt{3}$ find argument and modulus of given complex number

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2. Find the modulus and the arguments of the complex number $z = -\sqrt{} + i$

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3. write polar form of this complex number

$1 - i$

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4. write polar form of this complex number

$-1 + i$

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5. $-1-i$ convert in polar form.

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6. Convert of the complex number in the polar form: 3

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7. Convert of the complex number in the polar form: $\sqrt{}+i$

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8. i

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Exercise 5 3

1. Solve the equation:$x^2 + 3 = 0$

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2. Solve the equation:$2x^2 + x + 1 = 0$

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3. Solve the equation:$x^2 + 3x + 9 = 0$

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4. Solve the equation:$x^2 - x + 2 = 0$

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5. Solve the equation:$x^2 + 3x + 5 = 0$

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6. Solve the equation: $x^2 - x + 2 = 0$

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7. Solve the equation: $\sqrt{2}x^2 + x + \sqrt{2} = 0$

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8. Solve the equation: $\sqrt{3}x^2 - \sqrt{2}x + 3\sqrt{3} = 0$

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9. Solve the equation: $x^2 + x + \frac{1}{\sqrt{2}} = 0$

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10. Solve the equation: $x^2 + \frac{x}{\sqrt{2}} + 1 = 0$

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Miscellaneous Exercise

1. Evaluate : $\left[i^{18} + \left(\frac{1}{i}\right)^{25}\right]^3$

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2. For any two complex numbers z_1 and z_2, prove that $Re(z_1 z_2) = Rez_1 Rez_2 - |mz_1|mz_2.$

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3. Reduce $\left(\frac{1}{1-4i} - \frac{2}{1+i}\right)\left(\frac{3-4i}{5+i}\right)$ to the standard form.

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4. If under root of (a+i b)/(c+i d)=x+i y , Prove (a^2+b^2)/(c^2+d^2)= (x^2+y^2)^2

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5. Convert the following in the polar form : (i) $\frac{1+7i}{(2-i)^2}$ (ii) $\frac{1+3i}{1-2i}$

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6. Solve the equation : $3x^2 - 4x + \frac{20}{3} = 0$

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7. Solve the equation :$x^2 - 2x + \frac{3}{2} = 0$

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8. Solve the equation :$27x^2 - 10x + 1 = 0$

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9. Solve the following quadratic: $21x^2 - 28x + 10 = 0$

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10. If $z_1 = 2 - i$, $z_2 = 1 + i$, find $\left| \frac{z_1 + z_2 + 1}{z_1 - z_2 + i} \right|$

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11. If $a + ib = \frac{(x+i)^2}{2x^2+1}$, prove that $a^2 + b^2 = \frac{\left(x^2+1\right)^2}{\left(2x^2+1\right)^2}$

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12. If $z_1 = 2 - i, \ +2 = \ -2 + i,$ find : $Re\left(\frac{z_1 z_2}{z_1}\right)$

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13. Find the modulus and argument of the complex number $\frac{1+2i}{1-3i}$.

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14. Find the real numbers x and y if $(x - iy)(3 + 5i)$is the conjugate of $-6 - 24i$.

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15. Find the modulus of $\frac{1+i}{1-i} - \frac{1-i}{1+i}$

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16. If $(x+iy)^3 = u+iv$, then show that $\frac{u}{x}+\frac{v}{y} = 4(x^2-y^2)$.

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17. If $\alpha$and $\beta$are different complex numbers with $|\beta| = 1$, then find $\left|\frac{\beta-\alpha}{1-\overline{\alpha}\beta}\right|$.

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18. Find the number of non-zero integral solution of the equation $|1-i|^x = 2^x$

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19. If $(a+ib)(c+id)(e+\quad \text{if} \quad)(g+ih) = A+iB$, then show that $(a^2+b^2)(c^2+d^2)(e^2+f^2)(g^2+h^2) = A^2+B^2$

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20. If $\left(\frac{1+i}{1-i}\right)^m = 1,$ then find the least positive integral value of m.

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